AFOSR-TR-96

0351

REPO..T DOCUMENTATION PAGE

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	November 15, 1995	Final Report, 1992-1995

4. TITLE AND SUBTITLE

Probabilistic Methods for Global Optimization in Continuous Variables

5. FUNDING NUMBERS

G - F49620-92-J-0248 DEF

6. AUTHOR(S)

Dr. Fred Glover

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

University of Colorado-Boulder
College of Business, CB 419, Boulder, CO 80309

8. PERFORMING ORGANIZATION REPORT NUMBER

153-8100

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Dr. Neal Glassman
AFOSR/NM
Directorate of Mathematical & Information Sciences
Building 410
Bolling AFG, DC 20332-6448

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

F49620-92-J-0248-DEF

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

University Archives
Norlin Library
University of Colorado
Boulder, CO 80309

DISTRIBUTION ... Approved ... release; ... unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

During the past year, research effort has been focused on the analysis of problem structure to aid in the development and enhancement of heuristics and algorithms for combinatorial optimization problems. This report provides an overview of each of these problems.

19960726 076

14. SUBJECT TERMS

Probabilistic analysis,global investigation, mathematical programming, search methods.

15. NUMBER OF PAGES

2

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

FINAL TECHNICAL REPORT

Grant: F49620-92-J-0248 DEF

Dr. Fred Glover
College of Business and Administration
University of Colorado-Boulder
Campus Box 419
Boulder, Colorado 80309-0419

November 15, 1995

FINAL TECHNICAL REPORT

November 15, 1995

Principal Investigator:Dr. Fred Glover
College of Business, CB 419
University of Colorado
Boulder, Colorado 80309

Grant: F49620-92-J-0248,DEF

Mark Parker has completed and defended his doctoral dissertation, "A Set Covering Approach to Infeasibility Analysis of Linear Programming Problems and Related Issues," under the direction of Professor Jennifer Ryan. In his Ph.D. dissertation, Dr. Parker develops an integer programming constraint generation algorithm for the problem of finding the maximum cardinality feasible subsystem in an inconsistent set of linear inequalities, explores the polyhedral structure of this special covering problem, and explores the utility of the algorithm on the related linear discriminant problem. The algorithm is shown to be of practical use in aiding in the analysis of infeasible linear programs, providing more debugging information in time comparable to that needed for current state of the art analysis processes.

In addition, he has explored the underlying theoretical structure of the set covering polyhedron at the core of this problem. A key result is the proof that all constraints of this covering problem are facet defining, which provides insight into why this problem, although NP hard, is quickly solvable in many instances. He has also extended this work to the linear discriminant problem, where the algorithm provides the separator which minimizes the actual number of misclassifications, as opposed to minimizing some measure of misclassification. The following paper from his thesis work has been accepted for publication:

M. Parker and J. Ryan, "Finding the Minimum Weight IIS Cover of an Infeasible System of Linear Inequalities," to appear in "Annals of Mathematics and Artificial Intelligence."

The following papers are in preparation from this work:

M. Parker and J. Ryan, "Facial Properties of the Minimum Weight IIS Cover Polyhedron."

and

M. Parker and J. Ryan, "A Mathematical Programming Approach to the Linear Discriminant Problem."

In addition, work was completed by Dr. Glover, Dr. Parker, and Dr. Ryan on developing a new tabu search based branch and bound algorithm for coloring graphs. This effort led to the development of a new branch and bound algorithm which proved to be more effective over a wide range of problems than the state of the art DSATUR algorithm combined with branch and bound. This tabu branch and bound algorithm is capable of executing searches of varying degrees of exhaustiveness at different stages and in different regions of the search space, ranging from pure heuristic search to pure tree search at the extremes. The goal of this effort was to find near optimal colorings efficiently with the additional ability to obtain optimal colorings if desired. In motivating this approach, new theoretical results concerning the depth and width of local optima were introduced. Computational experiments were made comparing the tabu branch and bound method in both heuristic and exact mode with an efficient implementation of the DSATUR branch and bound algorithm. The tabu branch and bound approach was able to solve problem instances in 1/3 to 1/2400 of the time as DSATUR.

The following paper from this work has been accepted for publication:

F. Glover, M. Parker, and J. Ryan, "Coloring with Tabu Branch and Bound," to appear in "Cliques, Coloring, and Satisfiability: Second DIMACS Implementation Challenge," David S. Johnson and Michael A. Trick (eds.), "DIMACS Series in Discrete Mathematics and Theoretical Computer Science."

Additionally, a collaborative project between Dr. Glover, Dr. Parker, and Dr. Holly Zullo is on-going to develop an adaptive memory heuristic with probabilistic guidance for the travelling salesman problem.

A collaborative project between Dr. Glover and doctoral student Jiefeng Xu is also under way to develop a global optimization solution procedure for the mixed continuous and discrete programming problem of finding optimal generalized Steiner trees for telecommunications networks. Mr. Xu has programmed and tested a preliminary method for solving Steiner Tree telecommunication planning problems. This work has been presented in a keynote lecture by Professor Glover at the International Meeting of the Telecommunications Society in May 1995. Two papers have been produced of this work, which have been submitted for publication.